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August 5, 1999

T. Greengard
Waste & Remediation Operations
Kaiser-Hill, L.L.C.
Building 130, RFETS

ALTERNATIVE DEVELOPMENT FOR THE SOLAR PONDS PLUME - ALP-053-99

Attached is a brief description of the process used to develop a remedial alternative for the Solar Ponds Plume. Please let me know if you require additional information.

A L Primrose

A. L. Primrose
Project Manager, Groundwater Remediation

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Enclosure:
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cc:
L. Butler, B130

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Solar Ponds Plume Project
History of Alternatives

A plume of nitrate and uranium contaminated groundwater is derived from the Solar Evaporation Ponds, which were used to store and evaporate radioactive and hazardous liquid wastes. These ponds were drained and sludge removal was completed in 1995. To dewater the hillside, six interceptor trenches were installed in 1971. The original six trenches were abandoned in place and the current Interceptor Trench System (ITS) was installed in 1981. The ITS is generally keyed into bedrock and effectively collects most of the water; however, up to one third of the groundwater underflows the collection system, and eventually discharges to North Walnut Creek (Final Phase II RCRA RFI/RI Work Plan, OU4 SEPS, RF/ER-94-00040, DOE 1994).

On average, approximately 2.4 million gallons of water are collected from the ITS each year, pumped to the modular storage tanks for storage, and then pumped to Building 374 for evaporation. The current cost for all water treatment at Building 374 is $3.3 million per year, with approximately 84 to 90% of the water treated derived from the ITS. The cost to collect and store the ITS water is $240,000 per year. The entire $3.3 million cost will not be saved due to the high cost of maintaining this building to accomplish any water treatment. Based on conversations with the Building 374 personnel, an alternative to treating the water normally collected by the ITS will result in immediate cost savings of at least $500,000 per year due to reduced maintenance costs.

For many years, the Site, in conjunction with CDPHE and EPA, has looked for an effective and less expensive approach for treatment of the ITS water. The agencies, as well as neighboring cities, joined the Site in developing new stream standards to support the 1996 Rocky Flats Cleanup Agreement. Among the changes were less stringent nitrate and nitrite standards in Segment 5 of Walnut Creek that would allow for the cost-effective treatment of ITS water. The Colorado Water Quality Control Commission unanimously adopted the new standards only after Site representatives testified that some form of treatment would be applied before ITS water entered Walnut Creek. These treatment alternatives were first documented in *The Management Plan for the Interceptor Trench System Water* (RF/ER-96-0031.UN, 1996), followed by a more rigorous evaluation in the *Solar Ponds Plume Remediation and ITS Water Treatment Study* (RF/RMRS-97-093.UN, 1997a), and, finally, in the Solar Ponds Plume Decision Document (RF/RMRS-98-286, 1999).

A Water Working Group technical group was established to assist in the selection of an alternative by using techniques to develop creative alternatives, and to evaluate the more traditional alternatives. Use of the existing Interceptor Trench System (status quo) and direct discharge of the ITS without additional treatment were not pursued due to objections by the agencies and Water Working Group. In particular, CDPHE stated on May 22, 1998 that since the ITS and MSTs were partially remediating the plume, then 100% compliance must be demonstrated for any new action. Further discussions were held with the regulatory agencies, however, the need for an enhanced system continued to be a requirement. Based on that requirement, the passive barrier alternative was developed. Design of the remedial alternatives followed the RFCA decision process and was approved by DOE, EPA and CDPHE.

Uncertainties were identified and were included in the screening process. These included the expected reduction in North Walnut Creek flow rates, reduction in influent groundwater flow, and uncertainties concerning nitrate and uranium contaminant movement.

A simplified modeling effort was performed to evaluate and screen the alternatives remaining from the 1997 alternatives analysis. This model was not intended as a rigorous evaluation of contaminant flow within the complex hydrogeologic conditions present at the Solar Ponds Plume area, but as a conservative approach to screening potential remedial actions. The model is a two-dimensional slice through the middle of the plume, with the highest concentrations applied to the entire plume area. The model was not rigorously tied back to the data, and numerous assumptions were made concerning hydrogeologic conditions and contaminant concentrations within the plume. This modeling effort was not completed as no alternatives were identified through the initial modeling to be carried forward for additional evaluation.

The cost of acquiring additional data and performing additional modeling to develop a more accurate model of the plume was investigated and was estimated at approximately $300,000. However, the additional modeling was not expected to alter the approach for this project.

The current remedial action was selected in accordance with the two-step alternative selection process described in the RFCA Implementation Guidance Document (DOE, 1997). This process consists of an initial screening to select the best alternatives followed by a comparative analysis of the alternatives. Both the screening and the comparative analysis are based on the three following criteria:

1) **Effectiveness** - Includes protectiveness of public health, workers, and the environment, ability to attain ARARs, the level of treatment/ containment, residual effect concerns, and the ability to maintain protectiveness on an long-term basis. The ability to remove or immobilize both nitrates and uranium was considered when evaluating effectiveness.

2) **Implementability** - Includes the technical feasibility, availability of resources, and administrative feasibility. It also includes implementability based on land-use restrictions due to Preble's Meadow Jumping Mouse (Preble's Mouse) habitat.

3) **Cost** - Includes capital costs, operation costs, maintenance costs, and present worth analysis. Operation and maintenance costs are assumed to include sampling and analysis. Waste disposal costs, aside from some transportation and sampling costs, are not included in the estimate. Costs are escalated five percent for outyears.

NEPA values played an important role in alternative selection. In particular, new emphasis was placed on preserving the habitat of Preble's Mouse, a threatened species under the Endangered Species Act. The habitat lies north of the Solar Ponds along the North Walnut Creek drainage. The habitat plays an important role in the decision making process because it affects both the effectiveness (through the alternatives ability to attain ARARs and to be protective of the environment) and the implementation of an alternative (feasibility of an alternative is restricted by the defined habitat of Preble's Mouse).

Emphasis was also placed on alternatives that would serve as a long-term solution, hence, more emphasis on passive remediation methods were favored. A long-term approach is defined as an approach that can effectively mitigate the contaminants indefinitely, after plant systems are shut down and RFETS has undergone closure. This approach eliminated the following alternatives from future consideration in the screening process:

- Evaporation at Building 374
- Treatment at MSTs
- Constructed Wetland
- Off-Channel Evaporation Pond Enhanced Evaporation
- Dispersion Field (Leach Field)
- Early Capping of the Solar Ponds
- Enhanced ITS
- Recirculating Water to Solar Ponds
- Injection of Organic Liquids
- Ex Situ Metal Treatment Process
- Denitrification Unit at ITS Pump House
- Pave the ITS

The screening of the major alternatives is summarized in Table 1. All of the alternatives considered are included as an attachment to this document.

Table 1. Screening of Final Alternatives for Solar Pond Plume - from Solar Ponds Plume Decision Document (RF/RMRS-98-286, 1999).

Alternative	Description	Screening Results
1) No Action (Direct Release)	No action is defined as no collection and no treatment of groundwater. Abandonment of the ITS would be included under this option. The no action alternative supports the requirements of NEPA for remedy selection.	**Selected** – Low cost, meets NEPA requirements for alternative analysis, does not effectively treat contaminants
2) Managed Release	Construct a pipeline to redirect flow from ITS to Pond A-4. When a surface water standard for nitrate of 100 mg/l is implemented, the ITS would be abandoned in place and groundwater would flow directly into North Walnut Creek.	**Selected** – Meets surface water requirements, not as disruptive to Preble's Mouse habitat, low cost
3) Treatment at Building 995	Continued use of the ITS and the MSTs. Water would be transferred to the STP(Building 995) instead of Building 374 evaporator.	**Selected** – Modifications are simpler to implement, not as disruptive to Preble's Mouse habitat although the cost is high
4)Phytoremediation	Use of deep-rooted vegetation to passively intercept and treat SPP.	**Selected** – Long term approach, highly effective on nitrate, Disruptive to Preble's Mouse habitat
5) Reactive Barrier	Reactive barrier utilizing zero-valence iron and an organic media to reduce the uranium and the nitrate. ITS would back up system to ensure nitrate removal.	**Selected** - Effective system for uranium removal, not as disruptive to Preble's Mouse Habitat

Table 1 – Continued

Alternative	Description	Screening Results
6) Evaporation at Building 374	This is a continuation of current interim action. Water from the ITS is pumped to the MSTs and then to the Building 374 evaporator.	**Screened Out** - Not a long-term approach. It relies on the continued operation of the 374 evaporator
7) Treatment at MSTs	A 30-gallon per minute treatment system utilizing chemical precipitation, membrane filtration, and biodenitrification.	**Screened Out** - High Cost, Requires the construction of a new treatment system when existing systems at 995 and 374 could be used. Potential to greatly disturb Preble's Mouse Habitat, not a long-term solution
8) Constructed Wetland	Under this alternative a wetland would be constructed away from the A-Series ponds.	**Screened Out** – Would be disruptive to Preble's Mouse habitat
9) Off-Channel Evaporation Pond	Water is sent to a lined evaporation pond in the buffer zone instead of the MSTs. The pond would be approximately 4-5 acres.	**Screened Out** - would require use of undisturbed land, would impact Preble's Mouse habitat, not a long-term solution since closure would have to be done eventually on the evaporation pond
10) Enhanced Evaporation	MSTs would be utilized as evaporators. 132 spray nozzles would be installed at the top of each MST. Pumps would circulate the water. Enhanced evaporation would occur because the air to water interface area would be improved.	**Screened Out** - not a long-term approach, requires freeze protection
11) Dispersion Field (Leach Field)	Water is pumped from the MSTs to a leach field outside of the North Walnut Creek drainage. Leach field would be constructed out of 54 rows of parallel trenches.	**Screened Out** – would likely contaminate clean soil and water, not effective on uranium
12) Early Capping of the Solar Ponds	Place a cap on the Solar Ponds as an Interim Action to reduce groundwater flow and the mass flux of the contaminants	**Screened Out** – High cost, would not treat contamination in the groundwater, would not intercept plume, could be combined with another alternative
13) Enhanced ITS	Excavate the ITS and place collection pipe system about ten feet into bedrock.	**Screened Out** – Passive only if combined with a passive technology, would impact Preble's Mouse habitat
14) Recirculation of Water to Solar Ponds	Pump ITS water back into Solar Ponds	**Screened Out** – Did not work before, would cause slope stability problems, does not treat the water
15) Injection of Organic Liquids	An organic liquid such as molasses or acetic acid would be injected into the nitrate plume	**Screened Out** – Organics would increase biological oxygen demand in stream, ecosystem could be damaged by residual liquids
16) Ex Situ Metal Treatment Process	An ex situ treatment system using reactive iron would be used to reduce the nitrates.	**Screened Out** – Not a long-term solution, could generate trace amounts of other contaminants, non passive
17) Denitrification Unit at ITS Pump House	A mobile treatment unit that would denitrify the water using sewage treatment technologies.	**Screened Out** – Non-passive, not a long-term solution, high annual operating cost
18) Pave the ITS	Eliminate surface water flow into the ITS by paving over the most south collection trench since it is design to capture run-off.	**Screened Out** – Does not treat or intercept existing plume, could be combined with another alternative

The Reactive Barrier was recommended as the most suitable alternative. While Managed Release was a low cost alternative, based on discussions with regulatory agencies it was not viewed favorably. The Site has also committed to install some form of treatment in exchange for the relaxed stream standards.

The Reactive Barrier provided the greatest level of groundwater treatment of all the alternatives. It was selected for the following reasons:

- Nitrate levels are reduced.
- It offers the greatest degree of protectiveness.
- It has minimal impact to Preble's Mouse habitat.
- Most of the disruption during installation occurs outside the habitat area.
- It is a long-term solution.
- It does not require RFETS infrastructure after closure.
- The technology is available and is becoming more established with successful installations elsewhere.
- Groundwater flow is restored to its natural discharge location in the drainage system (i.e., under natural conditions, groundwater discharges to the North Walnut Creek drainage at the base of the hill slope).
- It offers the greatest degree of flexibility
- The reactive barrier is passive and low maintenance.
- Uranium would be removed.

Solar Ponds
Draft Remedial Alternatives

PROPOSED ALTERNATIVE	Option	BRIEF DESCRIPTION	ADVANTAGES	DISADVANTAGES
Use Existing ITS with a Treatment System				
B910		Treatment at Building 910 evaporation system	None	Building was tried previously and was not effective. Building is not operational and would require upgrades to be effective. Will require ITS and MSTs.
B374 treatment		Continued treatment at Building 374	Current system in use	Not a long-term treatment. High treatment costs. Continued upgrades for evaporators. MST and ITS repairs needed
995 Treatment		Treatment at existing sewage treatment plant	Existing facility, no treatment modifications required	Storage required to handle flow, nutrients need to be added, B995 decommissioned in 2006-not a long term solution
Enhanced ITS - with treatment elsewhere		Deepen existing ITS system to decrease underflow of contaminated groundwater	Will capture majority of contaminated groundwater	Treatment still required for captured water, ITS trench is in Preble's habitat and cannot be deepened. New collection trench would be required. Existing ITS already meets goals
Recirculating water to Solar Ponds		Pump water from ITPH to ponds for evaporation.	Less expensive than current situation	High operation and maintenance costs, was not acceptable in the past, could cause slope stability problems, not a long-term solution. RCRA issues may arise.
Passive Evaporation at ITPH		Installation of an 8 acre pond at the interceptor trench for evaporation		Not much space, in Prebles habitat, potential for overflow in inclement weather.
Treatment at MSTs (not evaporation)		Adding treatment media to MSTs	Effective	High operation and maintenance costs, slope stability problems, not a long-term solution, problems cleaning out the sludge.
Off-channel evaporation (isolated from Walnut Creek drainage)		Pump water from ITPH to a spray field, or pond		high operations and maintenance, spread of contamination to other areas, large area needed
Land Application		Use water to irrigate a crop	Used by many municipalities	May require storage of some of the winter flow, higher operations and maintenance costs. High natural concentrations of uranium.
Dispersion field - water stored in MSTs, sent to leach field		Pump water from ITPH to a leach field.		high operations and maintenance, spread of contamination to other areas, large area needed
Denitrification unit at ITPH		Installation of a commercial denitrfication unit at the ITPH	Effective	Long term constant operations and maintenance requirements and costs. Significant waste disposal.
Enhanced Evaporation		Evaporation in the existing Modular Storage Tanks	Same level of protection as current system, Utilizes existing equipment	Not a long term solution, operation and maintenance expenses, slope failure at MSTs makes solution problematic. Solids must be treated in B374
Los Alamos	metals treatment system	System treatment at ITPH	Unknown	Not proven technology, space requirements unknown, potential for Prebles habitat disruption, requires long-term operations and maintenance

Solar Ponds
Draft Remedial Alternatives

PROPOSED ALTERNATIVE	Option	BRIEF DESCRIPTION	ADVANTAGES	DISADVANTAGES
In-Situ Remediation				
Phytoremediation	Passive	Trees planted in small area to uptake nitrate from groundwater, no winter treatment	Passive, effective for part of the plume	Requires time and irrigation to establish, will not handle entire plume volume, requires additional clean water. Prebles Mouse habitat issues
	Enhanced	Trees planted over 50 acres to uptake nitrate from groundwater, no winter treatment	Effective for most of plume	Requires time to establish, requires maintenance past site closure, irrigation of plume water over area not in plume, requires additional clean water. Prebles Mouse habitat issues
Reactive Barrier	Iron/peat fill of one of the ITS branches	Passive flow through existing ITS system filled with reactive iron and peat moss	Uses existing system	Injection into ITS problematic, flow easily blocked with resulting slope stability problems, inability to replace or enhance media. ITPH flow is point source discharge. Slope stability issues possible if blockage occurs
	organics and iron	Installation of a collection system with treatment cells or gates.	Passive system, low operations and maintenance costs. Effectively treats nitrates, and uranium if required. Outflow from cells could be directed to stable areas.	Higher cost than other systems. Treatment media not yet determined, bench scale tests in progress
	Reactor vessels filled with reactive media at the ITPH		Similar to Mound project	Problems cleaning out the sludge from tanks, potential Prebles' habitat problems. Size of tanks unknown
	Chitin or bone char in ITS	Inject chitin or bone char into the present ITS system.	Known to be effective in reducing uranium contamination, not known whether this will reduce nitrates.	Injection into ITS problematic, flow easily blocked with resulting slope stability problems, inability to replace or enhance media. ITPH flow is point source discharge. Slope stability issues possible if blockage occurs
Injection of organic liquids (molasses/acetic acid)		Inject organic liquid into hillside	Known to be effective in reducing nitrate contamination	Liquids would tend to collect in ITS, then discharge to stream impacting BOD. Impossible to determine effectiveness prior to installation. Multiple injections required. Point source discharge from ITPH.
Limited Action Solutions				
Managed/Direct Release to:	A-1 Pond	Direct discharge from ITPH to Pond A-1	Low cost alternative	Pond would overflow, evaporation will not keep up. Prebles habitat. Ponds needed for spill control
	A-2 Pond	Direct discharge from ITPH to Pond A-2	Low cost alternative	Pond would overflow, evaporation will not keep up. Prebles habitat. Ponds needed for spill control
	N. Walnut Creek (direct release)	Direct discharge from ITPH to North Walnut Creek	Low cost alternative, exceedances of Nitrate standard not expected until site closure	Water flow in creek not known at time of site closure.
	Regulated release using new tanks at ITPH	Discharge from tanks into North Walnut Creek	Regulates flow into creek, exceedances of nitrate not expected until site closure	Water flow in creek not known at time of site closure.
Plugged ITS		Remove or plug entire ITS, groundwater exits to stream.	GW model shows that surface standards would be met in stream until 10 mg/l standard in plant at plant closure.	Slope stability problems would probably arise. Potential impact to PIDAS fence.
Plug downstream portion of ITS at ITPH		Block only the downgradient end of the ITS	Very inexpensive, model shows that this would be effective through site closure, but 10 mg/l not met then	Slumping would occur, uncontrolled wetlands would occur, after 2006 not effective.

Solar Ponds
Draft Remedial Alternatives

PROPOSED ALTERNATIVE	Option	BRIEF DESCRIPTION	ADVANTAGES	DISADVANTAGES
Capping Solar Ponds and hillside early		Push in berms, cap ponds and hillside	Reduce infiltration will reduce water flux to stream	Increase concentrations in groundwater. Model did not indicate much of a long-term advantage.
Reduce infiltration at ITS		Pave or cap the Solar Ponds Hillside	Reduces infiltration and flux through system, and therefore reduces flux to stream	Partly in Prebles Mouse habitat, will increase concentrations in groundwater, as with capping will not be a long term solution. Point source discharge to stream.
Constructed Wetland	Off-line, not in A Series ponds	evaporation and biodegradation of nitrates	Effective	Any suitable area is in Prebles' Habitat
	A Series pond	evaporation and biodegradation of nitrates	Effective	In Prebles' Habitat, insufficient capacity to handle volume. Ponds needed for spill control
Continued treatment until site closure, then free release.		Treatment at B374 or elsewhere, then free release after closure	Short term effectiveness	Not effective at Site closure.

Note: The no treatment options are highly dependent on flow after site closure